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Decomposition method for oligopolistic competitive models with common environmental regulation

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Abstract

© 2017 Springer Science+Business Media New YorkGlobal climate change has encouraged international and regional adoption of environmental policies aiming at reducing the generation of greenhouse gas emissions. Europe has taken the leadership in environmental regulations by introducing the European-Union Emissions Trading System (EU-ETS) in 2005 and other policies to mitigate carbon emissions and increase the efficiency of production processes. These environmental policies have significantly affected the production choices of the European energy and industrial sectors. In this paper, we consider a market where a set of players (firms) produce different commodities under a common environmental regulation that limits their emissions. Due to these environmental restrictions, the problem is treated as a generalized non-cooperative game where players have joint (environmental) constraints caused by the common and compulsory emission regulation. The problem is to find a natural mechanism for attaining the corresponding generalized equilibrium state. We suggest a share allocation method, which yields a suitable decomposition type procedure and replaces the initial problem with a sequence of non-cooperative games on Cartesian product sets. We also show that its implementation can be simplified essentially after the application of a regularized penalty method. In the case study, we take inspiration from the EU-ETS and we introduce an environmental regulation that restricts the carbon emissions of firms representing the energy, cement, and steel sectors respectively in Germany, France, Italy, and Spain. Our results confirm the important role played by energy sector in reducing carbon emissions.

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Keywords

Decomposable penalty method, Environmental regulation, Non-cooperative games, Oligopolistic competition, Regularized penalty method, Share allocation method